Sensitivity Analysis of 2015-based Northern Ireland Greenhouse Gas Emissions Projections

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Introduction

The 2030 Climate and Energy Framework contains a binding target to cut emissions in EU territory by at least 40% on 1990 levels by 2030. In addition, the UK Climate Change Act 2008 introduced legally binding targets to reduce Greenhouse Gas Emissions (GHG) emissions to at least 80% below the 1990 baseline by 2050, with interim targets of 35% by 2020, 50% by 2025 and 57% by 2030. Greenhouse gas emissions is also a population indicator in the draft Programme for Government (PfG)[1].

In line with the targets above, the projection tool was extended to 2030 this year. The latest NI GHG emissions projections estimate a 30.1% decrease in emissions between 1990 and 2030. This is based on the most recent NI GHG Inventory (2015). The full report can be accessed on the Statistics and Analytical Services Branch website: https://www.daera-ni.gov.uk/articles/northern-ireland-greenhouse-gas-inventory.

This projection is subject to change as methodologies are continually refined and more robust data sources are developed. However, irrespective of the routine updates, there are further uncertainties around the impact of economic conditions,

[1] For more information on the proposed PfG measure, visit the NI Executive website https://www.northernireland.gov.uk/programme-government or the CDWGCC Annual Progress Report https://www.daera-ni.gov.uk/publications/cross-departmental-working-group-climate-change-annual-report-2016

the extent to which assumed policy impact will actually be achieved, and the known weaknesses in existing data.

This sensitivity analysis will examine the effects that various economic and policy impacts, and possible data improvements could have on the current projected emissions. The contents list above summarises the scenarios which have been investigated. The results are presented in the body of the report. The possible data improvements are subject to further review and validation; if considered sufficiently robust they could be implemented in next year’s update to the projection tool.

Scenario 1 & 2 – high and low economic growth from Department of Business, Energy and Industrial Strategy (BEIS) updated energy and emissions projections

The projection tool incorporates economic growth assumptions as part of the BEIS modelling of energy trends. This data now also includes low and high growth scenarios so we can apply those to the projection tool for this sensitivity analysis.

The projection tool uses the baseline scenario for BEIS' energy and emissions projections so that policy savings can be added/subtracted without widespread double counting of emissions or savings. However, the low and high economic growth scenarios in BEIS' projections are provided relative to the reference scenario not the baseline scenario. Therefore, data from the reference scenario is added to the projection tool to create a new base to compare the low and high growth scenarios against.

The baseline scenario used in the central projection includes an average increase in UK Gross Domestic Product (GDP) of 2.25% per annum between 2016 and 2030. The reference scenario assumes the same level of GDP growth per annum.

The low growth scenario assumes an average UK GDP growth of 2.0% between 2016 and 2030 (scenario 1).

The high growth scenario assumes an average UK GDP growth of 2.5% between 2016 and 2030 (scenario 2).

Table 1 Impact of high and low economic growth scenarios on NI GHG emissions

Under this assumption	NI projected emissions reduction 1990-2030
Baseline[2] – relative to growth scenarios average of 2.25% GDP growth per annum	35.1%
Scenario 1 – low growth – average of 2.0% GDP growth per annum	35.6%
Scenario 2 – high growth – average of 2.5% GDP growth per annum	34.6%

[2] New baseline applied for scenarios 1 and 2. Original baseline is 30.1%

Scenario 3, 4, 5, & 6 – vary future levels of renewable electricity generation

The NI Executive's 2010-20 Strategic Energy Framework (SEF) includes a target to achieve 40% of electricity consumption from renewable sources by 2020. In 2017, 2,710 GWh of electricity in Northern Ireland was produced from indigenous renewable sources, equivalent to 34.8% of total electricity consumption[3]. The feasibility of the scenarios considered below was checked with Renewable Electricity Branch in Department for Economy (DfE). The scenarios will have widely differing probabilities of occurring, however these would be difficult to quantify.

The projection tool assumes that 40% of electricity will be produced from renewable sources by 2020 and it will remain at that level to 2030. This is the baseline scenario. Each alternative scenario is described below, with the effect on emissions shown in Table 2.

- Scenario 3 assumes renewable electricity generation reaches 35% by 2020 and remains at that level until 2030. This is based on the assumption that relatively low-level grid updates take place which do not provide sufficient capacity to meet existing targets. This is used in the 'worst case' set of scenarios in the conclusion of the report.

- In scenario 4 we consider the effect of an achievement of 35% by 2020 with increasing to 40% in 2025 and 2030. Again, this is on the basis that low level grid updates would take place and prevent the target from being met.

- Scenario 5 assumes that the 40% target will be met by 2020, increasing to 45% by 2025 and remaining at that level out to 2030. This assumes grid infrastructure would be in place to support it. The impact of this, and progress of other planned significant renewable energy projects, will need to be closely monitored. This is used in the 'best case' set of scenarios in the conclusion of the report.

- Scenario 6 considers that the 40% target will be achieved by 2020 and considers the possibility that 50% renewable energy generation is reached in 2025 and remains at that level to 2030. Again, this would assume that grid infrastructure would be in place to support it and that additional off-shore technologies would be well progressed by this time. Although possible, this is not considered likely.

[3] https://www.economy-ni.gov.uk/sites/default/files/publications/economy/Issue-8-Electricity-Consumption-and-Renewable-Generation-in-Northern-Ireland-January-2017-to-December-2017.pdf

Table 2 Impact of renewable energy generation scenarios on NI GHG emissions

Under this assumption	Impact on energy supply sector emissions 1990-2030	NI projected emissions reduction 1990-2030
Baseline –40% renewable energy by 2020, and remaining at that level to 2030	58.6% decrease	30.1%
Scenario 3 – 35% renewable energy by 2020, and remaining at that level to 2030	55.0% decrease	29.3%
Scenario 4 35% renewable energy by 2020 40% in 2025 and same in 2030	58.6% decrease	30.1%
Scenario 5 –40% renewable energy by 2020 and 45% by 2025 and same in 2030	62.3% decrease	30.9%
Scenario 6 –, 40% renewable energy by 2020 and 50% by 2025 and same in 2030	65.9% decrease	31.6%

Scenario 7 & 8 – high and low demand from SONI
The projection tool incorporates electricity demand using figures from SONI's (System Operator for Northern Ireland) All-Island Generation Capacity Statement 2017-2026 and SONI's system output. Given the degree of economic uncertainty in future, they provide three alternative scenarios which combine the economy, temperature and energy efficiency.

The projection tool uses the median electricity demand forecast which is based on an average temperature year, including energy efficiency with the central economic factor applied. This is their best estimate of what might happen in future.

The low demand scenario is based on a relatively high temperature year, higher energy efficiency with the pessimistic economic factor being applied (scenario 7).

The high demand scenario is based on a relatively low temperature year, lower energy efficiency with the more optimistic economic factor being applied. If it were to transpire there would be insufficient generation by 2024 (scenario 8).

Table 3 Impact of electricity demand scenarios on NI GHG emissions

Under this assumption	**Impact on energy supply sector emissions 1990-2030**	**NI projected emissions reduction 1990-2030**
Baseline – SONI median demand	58.6% decrease	30.1%
Scenario 7 – SONI low demand forecast	62.1% decrease	30.8%
Scenario 8 – SONI high demand	54.8% decrease	29.3%

Scenario 9 & 10 – high and low level from FAPRI-UK modelling

The projection tool incorporates estimated greenhouse gas emissions projections for livestock and agricultural soils based on figures from FAPRI-UK modelling. These are provided to us by AFBI (Agri-Food and Biosciences Institute) and include mean estimates as well as 10th and 90th percentile estimates.

The projection tool uses the mean scenario. For this sensitivity analysis we will consider low and high scenarios using the 10th and 90th percentiles respectively.

Table 4 Impact of high and low level scenarios on NI GHG emissions

Under this assumption	Impact on agricultural sector emissions 1990-2030	NI projected emissions reduction 1990- 2030
Baseline – FAPRI mean estimates	2.8% decrease	30.1%
Scenario 9 – FAPRI 10th percentile estimates	7.0% decrease	31.1%
Scenario 10 – FAPRI 90th percentile estimates	1.0% increase	29.1%

Scenarios 11 & 12 – high and low afforestation scenarios for land use change sector

The Centre for Ecology and Hydrology (CEH) projects emissions for the land use change sector. The projection tool assumes one of the baseline scenarios where afforestation drops to a low level after 2015 and remains at that level. Other activities are projected to continue at the 2000-2009 average rates. This is consistent with the baseline scenario that BEIS use in their energy and emissions projections.

In recent years planting rates have fallen short of the levels required to meet the long-term policy target of 12% woodland and forest cover by the middle of the century. The latest estimate (2017) for Northern Ireland is 8%.

Given this, an appropriate scenario might be to consider the impact based on current policies and funding (ending in 2021) continuing at the same rate into the future. Non-forest activities are projected to remain at 2014 rates and afforestation is expected to remain at 2014 rates until 2020 and then drop. This is scenario 11 in the table below and will be used as the worst case scenario.

Another scenario could be the stretch scenario which would assume ambitious climate change mitigation exceeding current policy aspirations or funding. This would involve consistent growth in afforestation rates out to 2030. This is scenario 12 in the table and has been used for the best case scenario.

Table 5 Impact of high and low level scenarios on NI GHG emissions

Under this assumption	Impact on land use change sector emissions 1990- 2030	NI projected emissions reduction 1990-2030
Central - Based on current policies and funding (as extant in 2014) continuing at the same rate into the future.	1.2% decrease	30.1%
Scenario 11 – Based on current policies and funding (ending in 2021) continuing at the same rate into the future.	25.1% increase	29.5%
Scenario 12 - This assumes an ambitious climate change mitigation programme exceeding current policy aspirations or funding.	42.6% decrease	31.0%

Scenarios 13 – impact of updated UK/NI split for landfill methane emissions

The projection tool uses UK-level projections for non-CO_2 greenhouse emissions projections. A NI/UK split is applied to these projections. The split is taken from the MELMod waste model used by Ricardo-AEA to estimate emissions. For the 2016 inventory, this model was updated to include activity data for each of the Devolved Administrations, i.e. a bottom-up model.

Landfill methane collection has proceeded at a slower rate in NI than in the rest of the UK. Therefore, NI makes a greater proportional contribution to UK methane emissions from 2016 onwards. From 1990-2015 NI landfill methane emissions were between 2.4% and 2.7%% of the UK emissions, this increased to 4.2% in 2016. Projections are based on a 5 year average and use a split of 4.55% between 2017 and 2030.

This results in a noticeable impact on the NI level emissions as seen in table 6 below. Emissions from the waste sector are not expected to decrease at the same rate due to the lower level of methane capture in NI and therefore emissions reduction in the sector and overall has lessened.

Table 6 Impact of updated waste emissions split on NI GHG emissions

Under this assumption	**Impact on waste management sector emissions 1990- 2030**	**NI projected emissions reduction 1990-2030**
Central – Based on 2.6%-2.7% NI/UK landfill methane emissions split	75% decrease	30.1%
Scenario 15 – Based on 4.55% NI/UK landfill methane emissions split	67% decrease	29.5%

Uncertainty in the projections – best and worst cases

By combining the results from each individual scenario of the sensitivity analysis it is possible to produce best and worst case combinations around the central estimate of a 30.1% reduction in GHG emissions from 1990 to 2030.

For the best case, the scenarios listed below were combined. The impact of all of these scenarios could be to reduce GHG emissions from 1990 to 2030 by 32.9%.

- 40% renewable energy by 2020 and 45% by 2025 and same in 2030
- SONI low demand forecast
- FAPRI 10th percentile estimates
- LULUCF using updated Stretch projections
- Impact of updated UK/NI split for landfill methane emissions

Note: the low growth scenario (average of 2.0% GDP growth per annum) is not used for the best case scenario as it requires electricity demand to be based on the reference scenario for projected emissions. It is more accurate to base electricity demand on SONI forecasts since these are specific to NI therefore the SONI low demand forecast has been used in the best case scenario. The SONI low demand forecast incorporates a GVA growth factor of 0.7%.

Note. There is a 'low' scenario in the LULUCF projections that is used in the emissions reduction plan and includes climate change mitigation policy aspirations for each of the devolved administrations and projects forward beyond 2021. Using this scenario the estimated reduction from 1990 to 2030 is 30.2% overall and 7.9% for the land use change sector so a similar effect to the central estimate hence the stretch scenario has been used even though it is ambitious and unlikely to happen. It gives an indication of the sensitivity of the tool to this type of data. LULUCF Stretch scenario requires an ambitious climate change mitigation program that exceeds current policy aspirations and funding.

For the worst case, the following scenarios were combined. The impact of these scenarios together could be a 26.9% reduction in GHG emissions by 2030, compared to 1990 levels.

-35% renewable energy by 2020 and remaining at that level until 2030
- SONI high demand forecast
- FAPRI 90th percentile estimates
- LULUCF projections based on central projections

Note: the high growth scenario (average of 2.5% GDP growth per annum) is not used for the best case scenario as it requires electricity demand to be based on the reference scenario for projected emissions. It is more accurate to base electricity demand on SONI forecasts since these are specific to NI therefore the SONI high demand forecast has been used in the best case scenario. The SONI high demand forecast incorporates a GVA growth factor of 2.7%.

Consideration of uncertainty around the 1990-2015 GHG Inventory trend

The projection is based on the most recent greenhouse gas inventory, which provides data from 1990 to 2015. However, the inventory itself has an uncertainty associated with the trend between 1990 and 2015. It estimates that the emissions reduction between 1990 and 2015 is between 9% and 29%, with a central estimate of 18%. It could be misleading to ignore this additional uncertainty around the central estimate (i.e. +9 percentage points/-11 percentage points) when projecting the inventory onwards to 2030.

More sophisticated simulation models would need to be used to provide a more robust estimation of the overall uncertainty (i.e. both inventory and projection) but would require further extensive analysis and specialist software. In the absence of such an in-depth analysis, the best that can be done is to assume that the inventory uncertainty between 1990 and 2015 remains constant, and fully additive, over the extended time period 1990 to 2030. The uncertainty around the trend has therefore been combined with the uncertainty resulting from the scenarios set out above to create upper and lower limits for each projection year out to 2030. For example, the total uncertainty range in 2030 would be 26.9% minus 9 percentage points and 33.5% plus 11 percentage points.

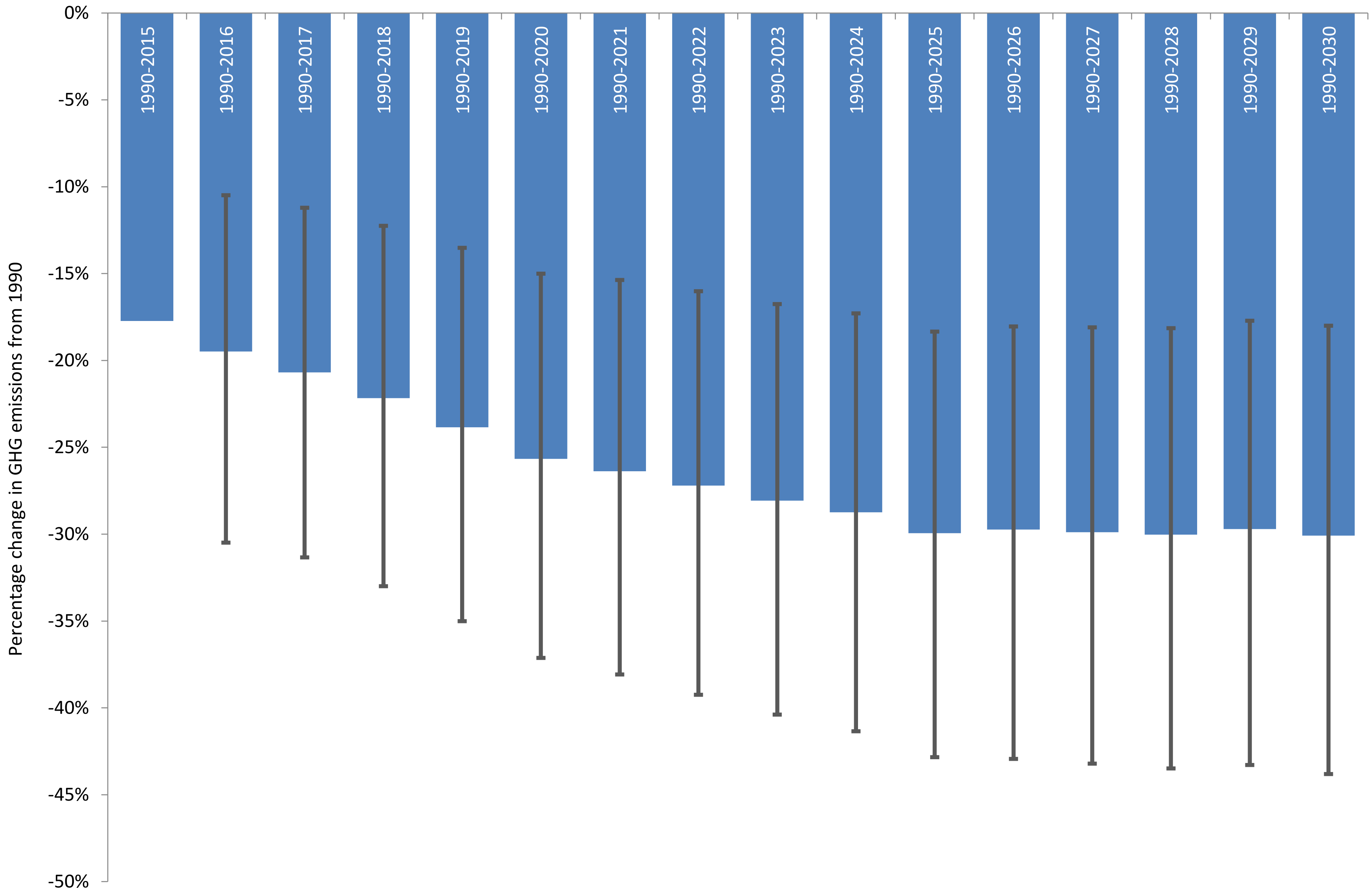
In reality the two sources of error will interact and hence are unlikely to be fully additive. In addition, the error in historical inventory is likely to diminish over time due to further improvements arisings from the inventory improvement programme. This analysis of overall uncertainty should therefore be regarded as purely illustrative.

Conclusion

By considering the best and worst cases, as well as accounting for uncertainty stemming from the inventory, a suggested range of uncertainty around the 2015-based projected emissions reduction of 31.2% would be 17.9% - 43.9%.

Figure 1 presents the projected emissions reduction for each year from 1990-2015 to 1990- 2030, also displaying overall uncertainty ranges associated with the projection. This sensitivity analysis only suggests a *possible* lower and upper bound based on the current ‘best’ and ‘worst’ reduction scenarios for NI at this point in time. It cannot take account of the future impact of more robust NI-specific data becomes available nor can it take account of NI-specific policies not yet included in the projection tool but which may be identified, or quantified, in future.

Work on estimating the uncertainty around the emissions inventories and projections has become a higher priority for the other Devolved Administrations. There is interest in data uncertainties as well as sector-specific uncertainties and uncertainties in reported trends. Statistics and Analytical Services Branch continues to discuss this and related work with colleagues in England, Scotland and Wales. There is scope for a more statistically robust methodology for estimating an uncertainty range around NI’s baseline greenhouse gas projections.


Percentage change in GHG emissions from 1990
0%
-5%
-10%
-15%
-20%
-25%
-30%
-35%
-40%
-45%
-50%
1990-2015
1990-2016
1990-2017
1990-2018
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